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teristic curve of a writer,—that is to say, if a curve is constructed from one hundred thousand words of a writer, taken from any one of his productions, then a second curve constructed from another hundred thousand words would be practically identical with the first,—and that this curve would, in general, differ from that formed in the same way from the composition of another writer, to such an extent that one could always be distinguished from the other. To demonstrate the

though not probable, that two writers might show identical characteristic curves.

T. C. MENDENHALL.

*TIDAL OBSERVATIONS OF THE GREELY EXPEDITION.*

THE principal tidal observations were made at Fort Conger, on Lady Franklin Bay, by various members of the expeditionary force working under

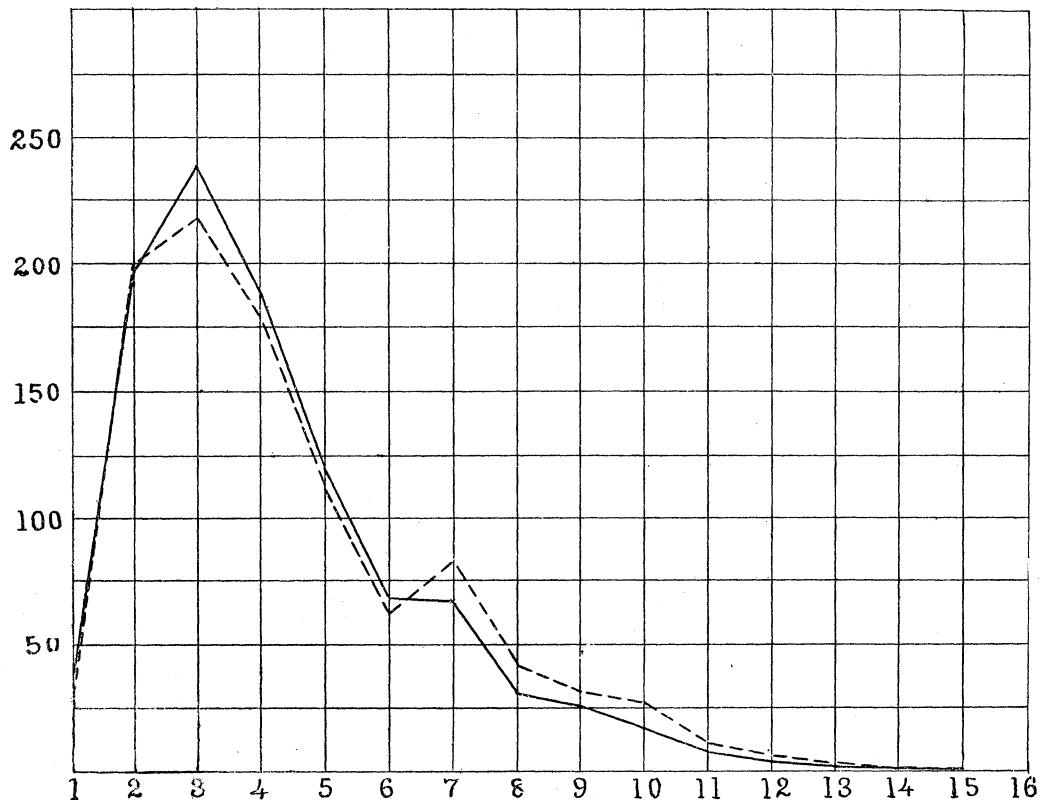


FIG. 10.—TWO GROUPS, OF FIVE THOUSAND WORDS EACH, FROM ADDRESSES OF EDWARD ATKINSON: ADDRESS TO WORKINGMEN, ——; TO ALUMNI OF THEOLOGICAL SEMINARY, - - -.

existence of such a curve will require the enumeration of the letters in several hundred thousand words from each of a number of writers. Should its existence be established, the method might then be applied to cases of disputed authorship. If striking differences are found between the curves of known and suspected compositions of any writer, the evidence against identity of authorship would be quite conclusive. If the two compositions should produce curves which are practically identical, the proof of a common origin would be less convincing; for it is possible, al-

direction of Sergt. Edward Israel, and with a general supervision by the commanding officer of the expedition. They consisted of hourly heights of the tide from Aug. 20, 1881, to July 1, 1882, and the times and heights of high and low waters from Aug. 20, 1881, to June 30, 1883, both series read from fixed staff gauges and practically continuous. A broken series of high and low waters from July 1 to Aug. 8, 1883, obtained under unfavorable conditions, were not used in the discussion. There were also short series at seven outlying stations on the coasts of Greenland and

Grinnell Land, and a casual observation of high water at the head of Greely Fiord, during the progress of the readings at Fort Conger, with a dozen or more high and low waters noted during the retreat through Kennedy Channel and Kane Basin. The original records, too bulky for easy transportation, were left stored at Fort Conger when the party abandoned that station; but close transcripts, previously prepared and carefully verified, were brought away by Lieutenant Greely,

at stations beset with heavy ice, even short series are, as a rule, sadly out of joint and comparatively worthless. Unless the stability of the gauge is absolutely assured, which can seldom be the case, only frequent resort to levels between the gauge and one or more permanent bench-marks on shore can insure scientific value to the observations. At Fort Conger the observations of the first year depended in this respect upon a gauge that seems to have been stable, those of the second upon

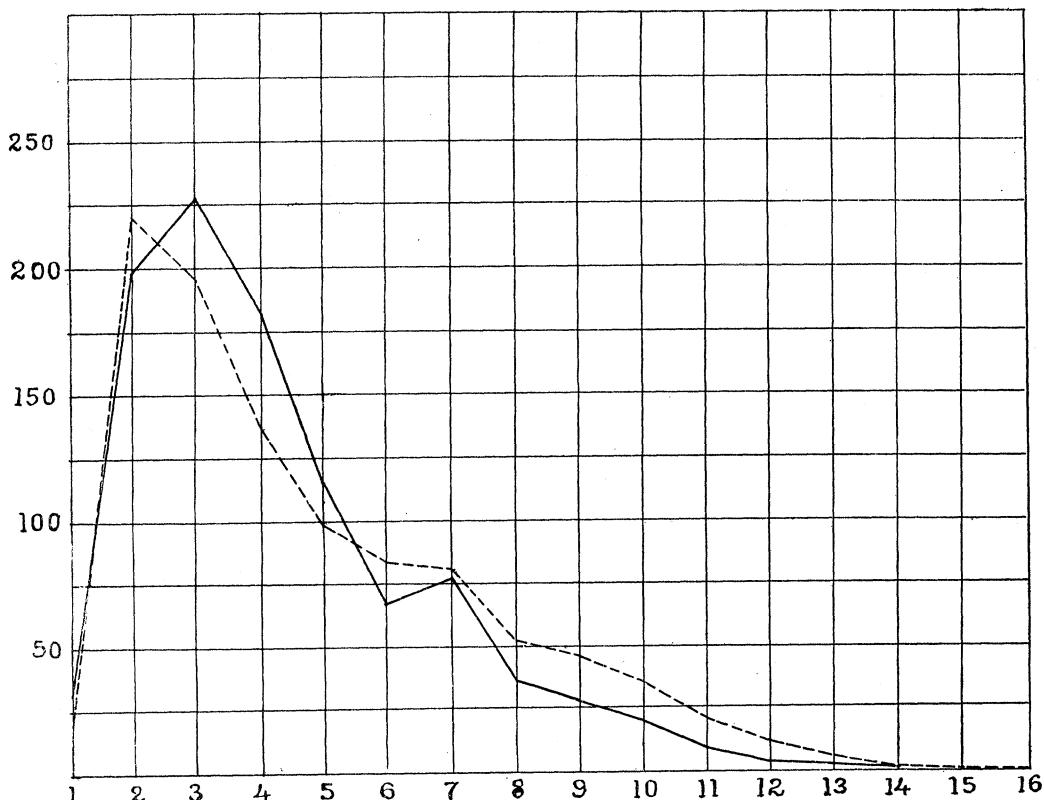


FIG. 11.—TWO GROUPS, OF TEN THOUSAND WORDS EACH. ATKINSON, ——: MILL, - - -.

and on his return to this country referred to the superintendent of the coast and geodetic survey, and later were placed in the hands of Mr. Alex. S. Christie, chief of the tidal division of the office, for reduction and discussion.

The weak point of tidal observations is almost invariably, even in middle latitudes, the instability of the staff and the undetermined fluctuations in altitude of the staff zero; so that it not infrequently happens that a satisfactory reduction of all the observations to the same plane of reference is a wholly intractable problem. In high latitudes,

series of spirit-levels. Only two months of the series were in much doubt, and a tolerably satisfactory adjustment of these was finally effected. The observations bear abundant internal evidence of a conscientious and persistent endeavor to secure trustworthy and precise results; and, although they are far from equalling observations of standard excellence in middle latitudes, they are believed to constitute the longest and best series ever brought back from the arctic seas.

Following are some of the results of a non-harmonic analysis of the observations at Fort Conger:

the mean lunital intervals are  $11^h 33^m 3$  and  $17^h 45^m 3$ ; the mean range is 1.328 metres; the semi-mensual curves for intervals and heights give the age of the tide 1.4 days, the moon tide 2.2 times the sun tide, and satisfy closely the equilibrium formulae of Bernouilli. The diurnal inequality in height is, in comparison with the whole tide, three times as small as in Smith Sound; the influence of the sun in producing it is practically equal to that of the moon; it van-

ishes for high water  $2^d 22^h$  after, for low water  $1^d 08^h$  before, the vanishing of the moon's declination, and the interval of the two former events appears to be independent of the solar declination. A method of graphical analysis, due to the late Assistant L. F. Pourtales of the U.S. coast survey, brings out the fact that the diurnal inequality at Fort Conger is caused by a wave that has a sidereal day for its mean period; the same thing is also shown to obtain at Port Foulke and Van Rensselaer harbor in Smith Sound, and at Thank God harbor in Polaris Bay. The general phenome-

non of diurnal inequality is then taken up as a problem in kinematics, the diurnal inequality wave is analyzed into its principal components, and the sidereal period shown to have place at still other stations both within and without the arctic circle, and to be a rule rather than an exception. The results of an harmonic analysis of the first year's observations will be found in the report: in so far as they relate to the same matters, they confirm the results previously found and stated above.

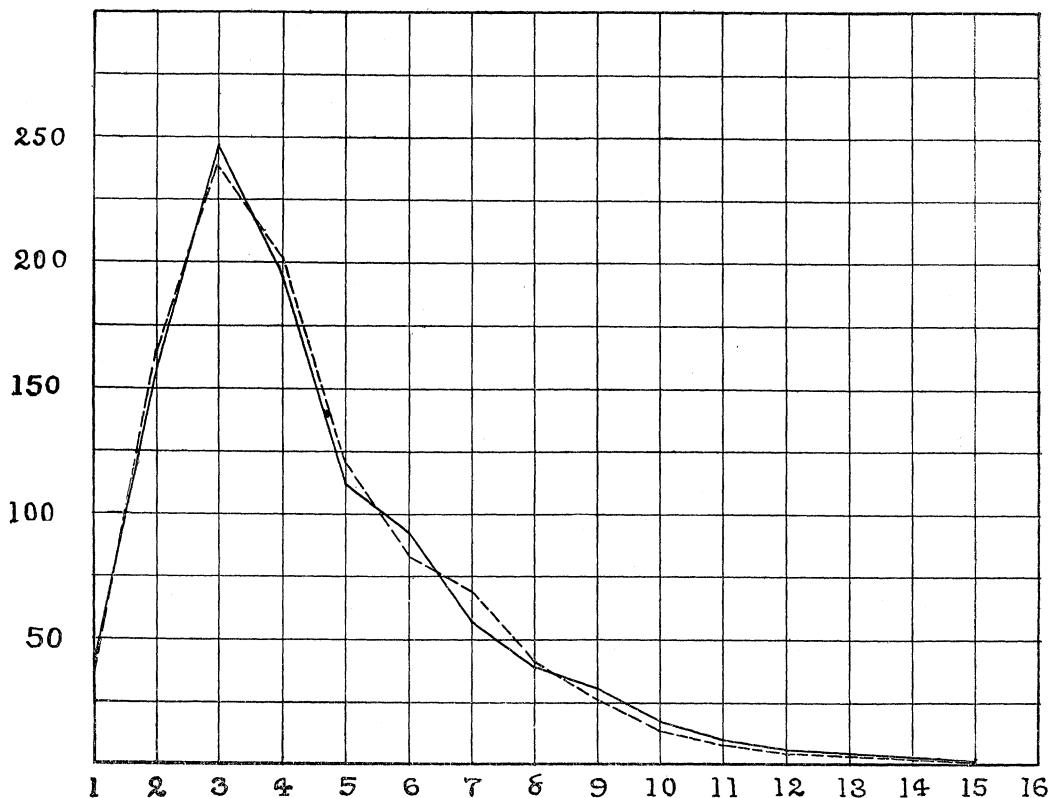


FIG. 12.—TWO GROUPS, OF TEN THOUSAND WORDS EACH, FROM DICKENS: 'OLIVER TWIST,' ——; 'CHRISTMAS CAROL,' - - -.

ishes for high water  $2^d 22^h$  after, for low water  $1^d 08^h$  before, the vanishing of the moon's declination, and the interval of the two former events appears to be independent of the solar declination. A method of graphical analysis, due to the late Assistant L. F. Pourtales of the U.S. coast survey, brings out the fact that the diurnal inequality at Fort Conger is caused by a wave that has a sidereal day for its mean period; the same thing is also shown to obtain at Port Foulke and Van Rensselaer harbor in Smith Sound, and at Thank God harbor in Polaris Bay. The general phenome-

A comparative study of the specific characters of the Fort Conger and other arctic tides with the cotidal lines, widths, and depths of the tidal avenues to the Polar Ocean, with whatever other tidal data from high latitudes was accessible, resulted in certain inferences stated in the report, and which may perhaps be tolerated here. The weakness of the tide-producing forces near the pole and a propensity to dissipate as a free wave as soon as formed, in waters of even moderate depth, are two causes operating to prevent the generation of local tides of appreciable magni-

tude in that region. The tides of the Pacific are not likely to make themselves felt in that vast expanse through a strait only some forty miles in width and less than thirty fathoms in depth, with far-stretching shoal approaches on either side. On the other hand, the relation of the Polar to the Atlantic Ocean is so intimate as to amount to identity. The continuity of the Atlantic basin has been demonstrated by soundings up to and beyond the 80th parallel. The channel between Spitzbergen and the European coast is about a

But the laws of the tides in the circumpolar seas, a *cul de sac* into which run the tides of an ocean stretching from pole to pole, and where the absence of controlling astronomical forces is favorable to tidal anarchy, can only be determined with certainty from long series of observations at stations generously distributed about the polar basin. The establishment and maintenance by Lieutenant Greely of one such station, and his preservation of the records of observation, will be regarded as substantial services to science

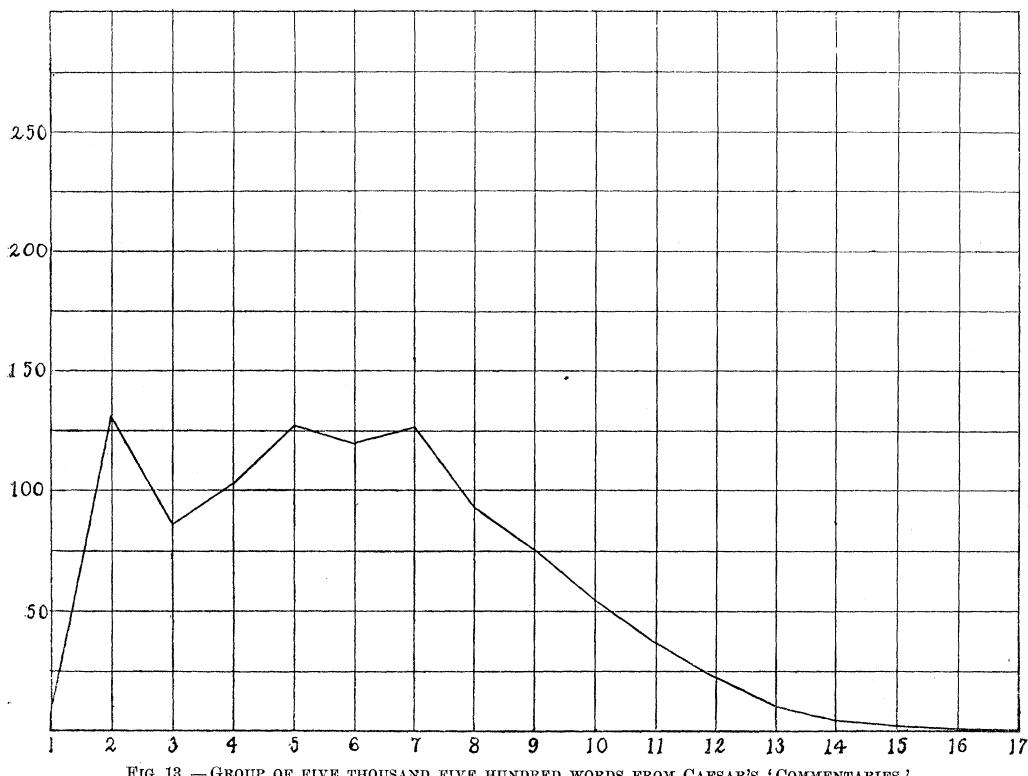


FIG. 13.—GROUP OF FIVE THOUSAND FIVE HUNDRED WORDS FROM CAESAR'S 'COMMENTARIES.'

hundred fathoms deep and four hundred miles in width; that between Spitzbergen and Greenland has about the same width, but is one, two, and three miles deep. The tides of the circumpolar seas cannot avoid forming a part of the Atlantic system. As to the tide in Lady Franklin Bay, it seems almost a certainty that it is chiefly an Atlantic tide that has flowed up through the Spitzbergen Sea, rounded Greenland, and entered Robeson Channel from the north, where it probably meets another and fainter Atlantic tide from the south, which, delayed and spent in the shallow West Greenland seas, comes into Lady Franklin Bay two or three hours later.

by all interested in this branch of physical inquiry.

A. S. C.

#### AGRICULTURE IN ENGLAND IN 1886.

IN outlining, in a recent number of *Science* (ix. No. 212), the reports presented by the British commission on the existing trade depression, special attention was called to the fact that it was admitted on all hands that the agricultural classes were the worst sufferers. The lower prices of agricultural produce were very far-reaching in their consequences. For this reason the latest returns as to that produce are of timely interest; and we con-